



Grid Modernization Initiative

Overview for the BNL / ISGAN Workshop on Modeling, Simulation, and More

DOE Team Leads

Bill Parks, Office of Electricity Delivery and Energy Reliability

Kevin Lynn, Office of Energy Efficiency and Renewable Energy

Presented by: Gil Bindewald, Office of Electricity Delivery and Energy Reliability

April 14, 2016



Why Grid Modernization?

The existing U.S. power system has served us well...
but our 21st Century economy needs a 21st Century grid.



Security Threats

A photograph of a city skyline at sunset, with the sun low on the horizon, casting a warm orange glow over the dark silhouettes of the buildings.

Changing Supply Mix

A photograph of two workers in safety gear installing solar panels on a residential roof. The panels are laid out in rows, and the workers are using tools to secure them.

Extreme Events

A photograph showing the aftermath of a disaster, likely a hurricane or earthquake. Debris, including twisted metal and broken wood, is scattered on the ground. In the background, a house is partially destroyed, and power lines are down.

New Market Opps.

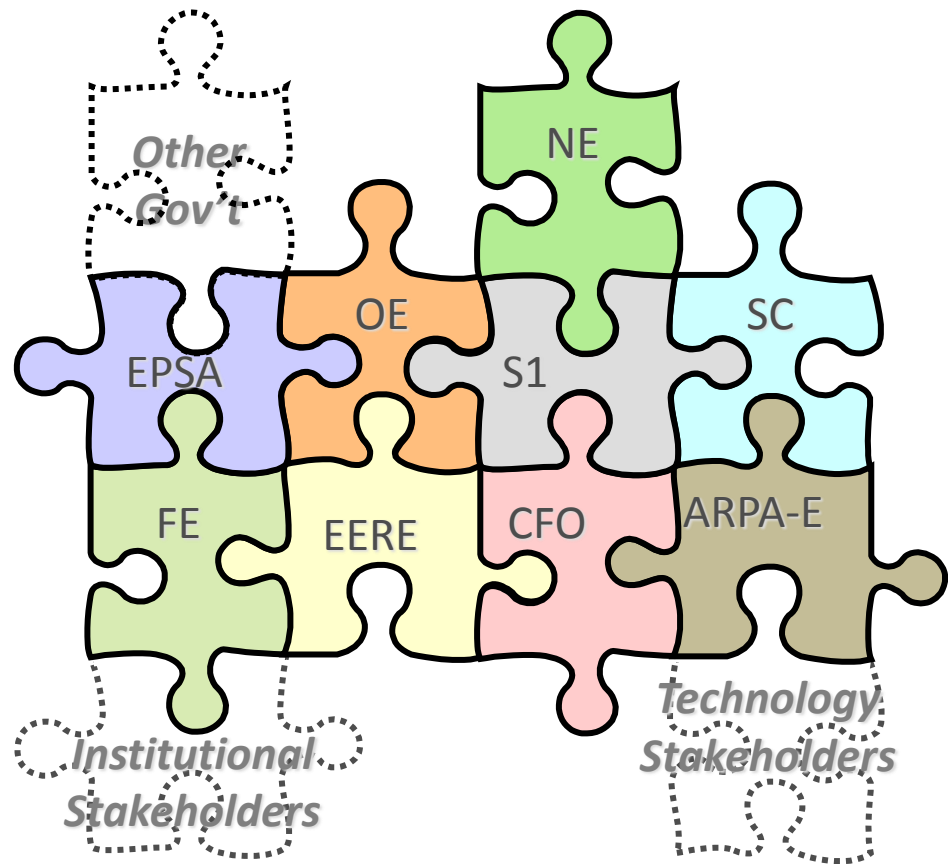
A photograph of a silver SUV driving on a paved road. In the background, there are wind turbines and mountains under a clear blue sky.



Grid Modernization Initiative

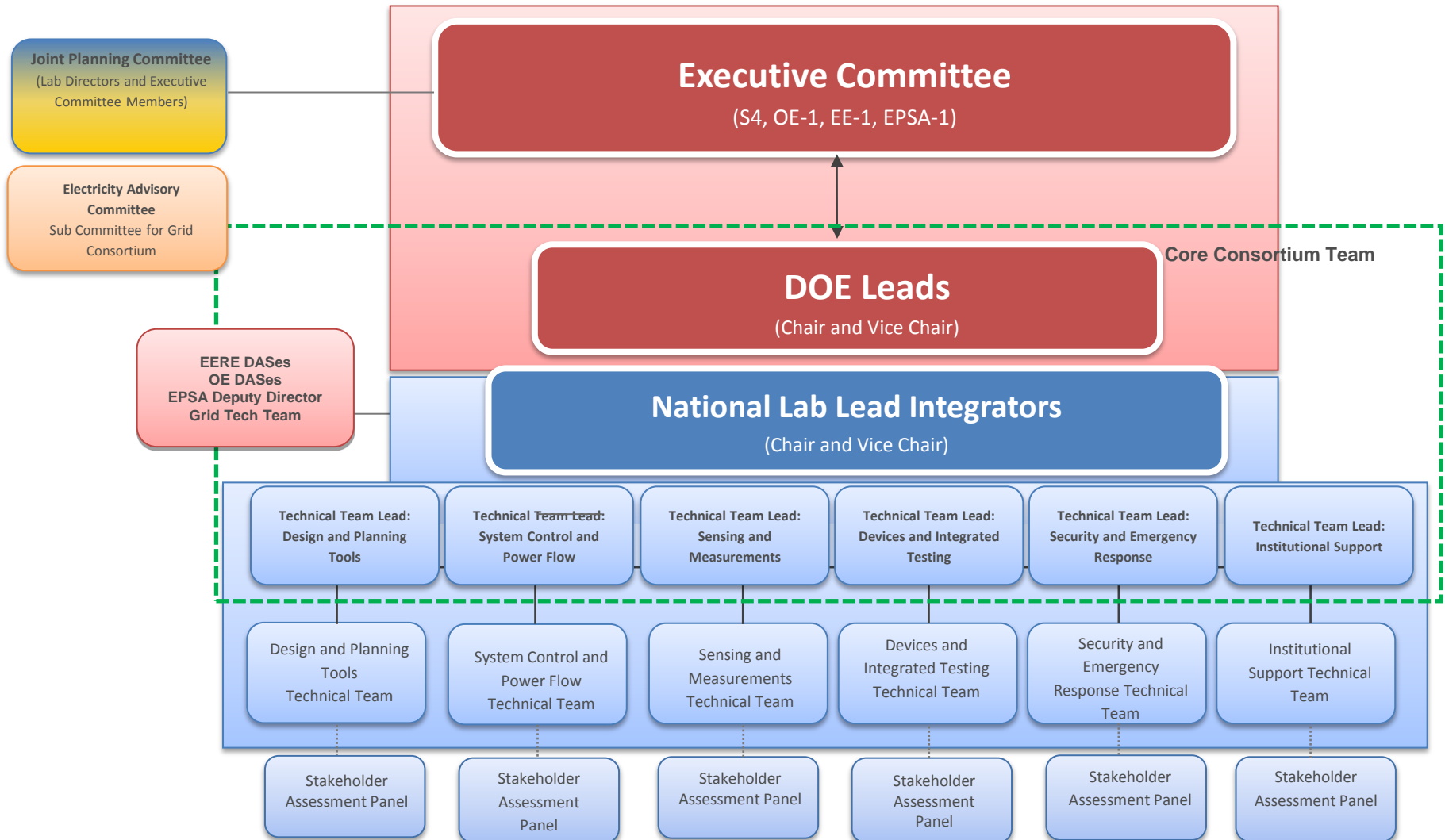
An aggressive five-year grid modernization strategy for the Department of Energy that includes

- Alignment of the existing base activities among the Offices
- An integrated Multi-Year Program Plan (MYPP)
- New activities to fill major gaps in existing base
- Development of a laboratory consortium with core scientific abilities and regional outreach





Grid Modernization Laboratory Consortium

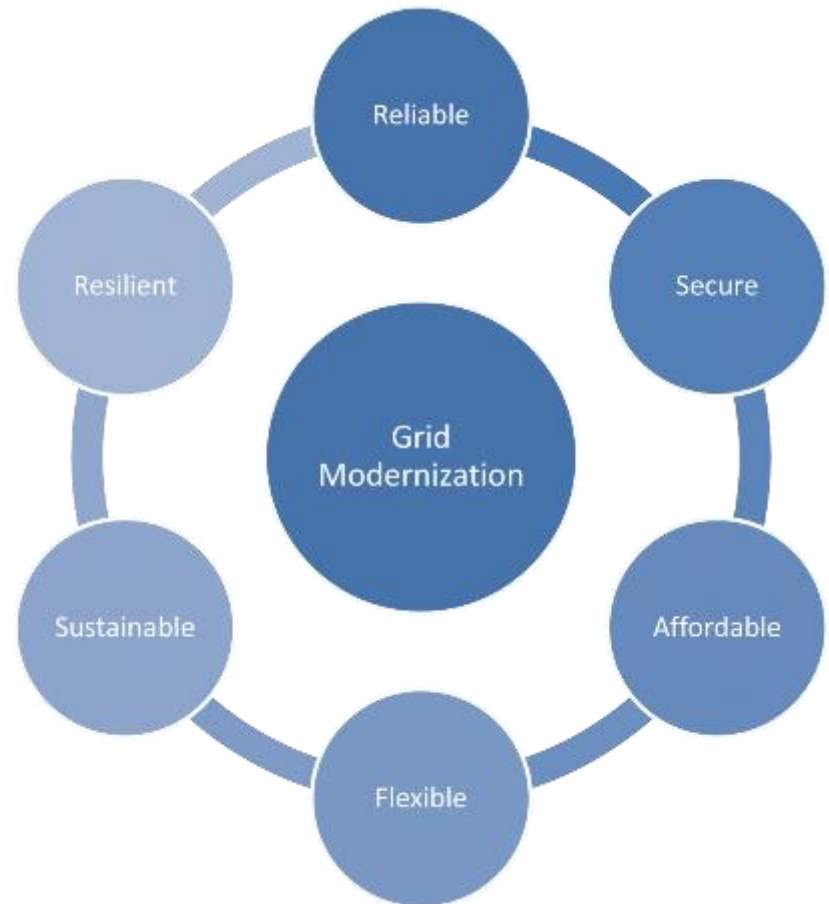




Grid Modernization Initiative

The vision of DOE's Grid Modernization Initiative (GMI) is:

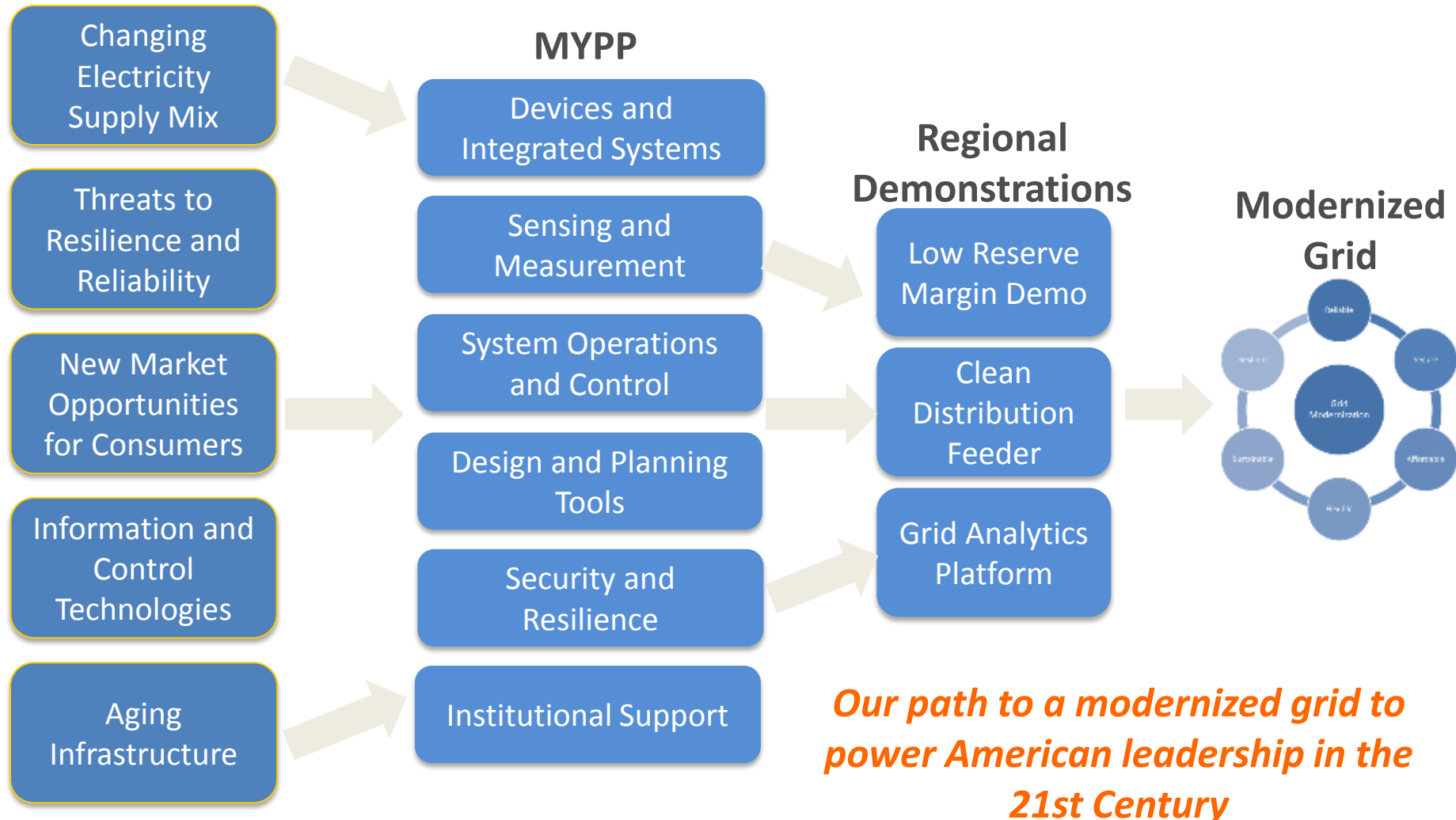
- A future grid that will solve the challenges of seamlessly integrating conventional and renewable sources, storage, and central and distributed generation.
- The future grid as a critical platform for U.S. prosperity, competitiveness, and innovation in a global clean energy economy.
- A future grid that will deliver **resilient, reliable, flexible, secure, sustainable, and affordable** electricity to consumers where they want it, when they want it, how they want it.





GMI Will Have National Impact

Drivers of change





GMI's Integrated Technical Thrusts

Technology Innovation

Institutional Support

- Provide tools and data that enable more informed decisions and reduce risks on key issues that influence the future of the electric grid/power sector

Design and Planning Tools

- Create grid planning tools that integrate transmission and distribution and system dynamics over a variety of time and spatial scales

System Operations, Power Flow, and Control

- Design and implement a new grid architecture that coordinates and controls millions of devices and integrates with energy management systems

Sensing and Measurements

- Advance low-cost sensors, analytics, and visualizations that enable 100% observability

Devices and Integrated System Testing

- Develop new devices to increase grid services and utilization and validate high levels of variable generation integrated systems at multiple scales

Security and Resilience

- Develop advanced security (cyber and physical) solutions and real-time incident response capabilities for emerging technologies and systems



DOE Grid Modernization Lab Call for FY16

- ***Category 1: Foundational Platform Activities***
 - Fundamental Analysis
 - Core Activities
 - Pioneer Partnerships
 - Technical Areas
 - *Proposals were coordinated across the GMLC-National Laboratory complex*
- ***Category 2: Program Office Specific Activities***
 - Topics that address their specific requirements for grid modernization
 - *Proposals solicited in the category undergo a traditional open lab call competition.*





Our Project Partners

Total Numbers and Representative List of Logos

24 Utilities and Power Producers
10 RTO/ISO and Reliability Orgs
25 Tech Developers and Vendors
15 Universities and Research Institutes
9 Federal Agencies

6 State Agencies and PUCs
15 Industry and Professional Associations
5 Policy and Regulatory Associations
14 Standards Bodies and Testing Companies



Independent Electrical Contractors

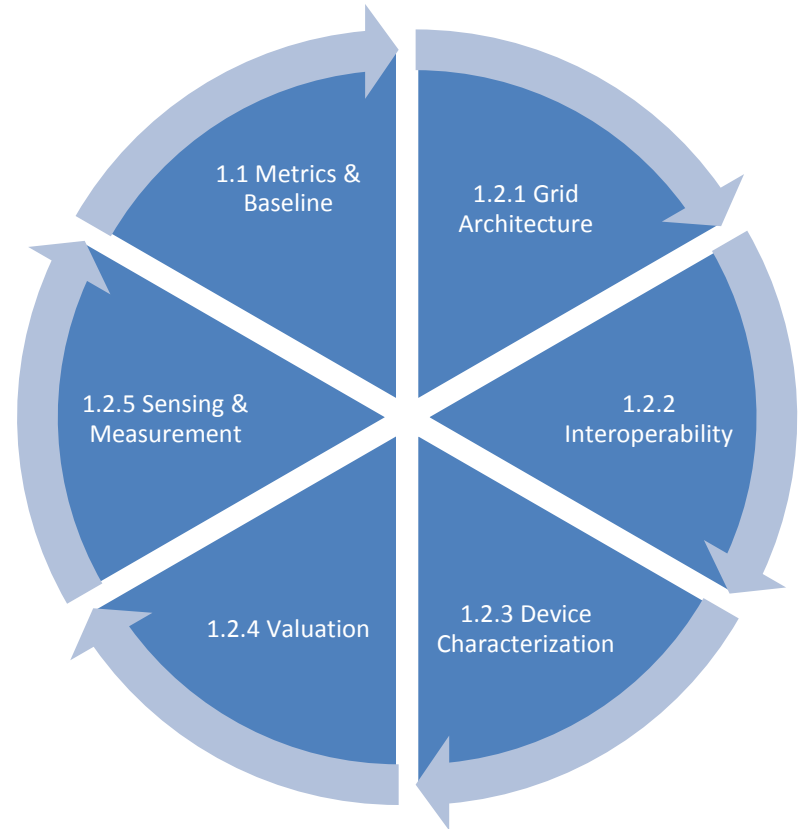




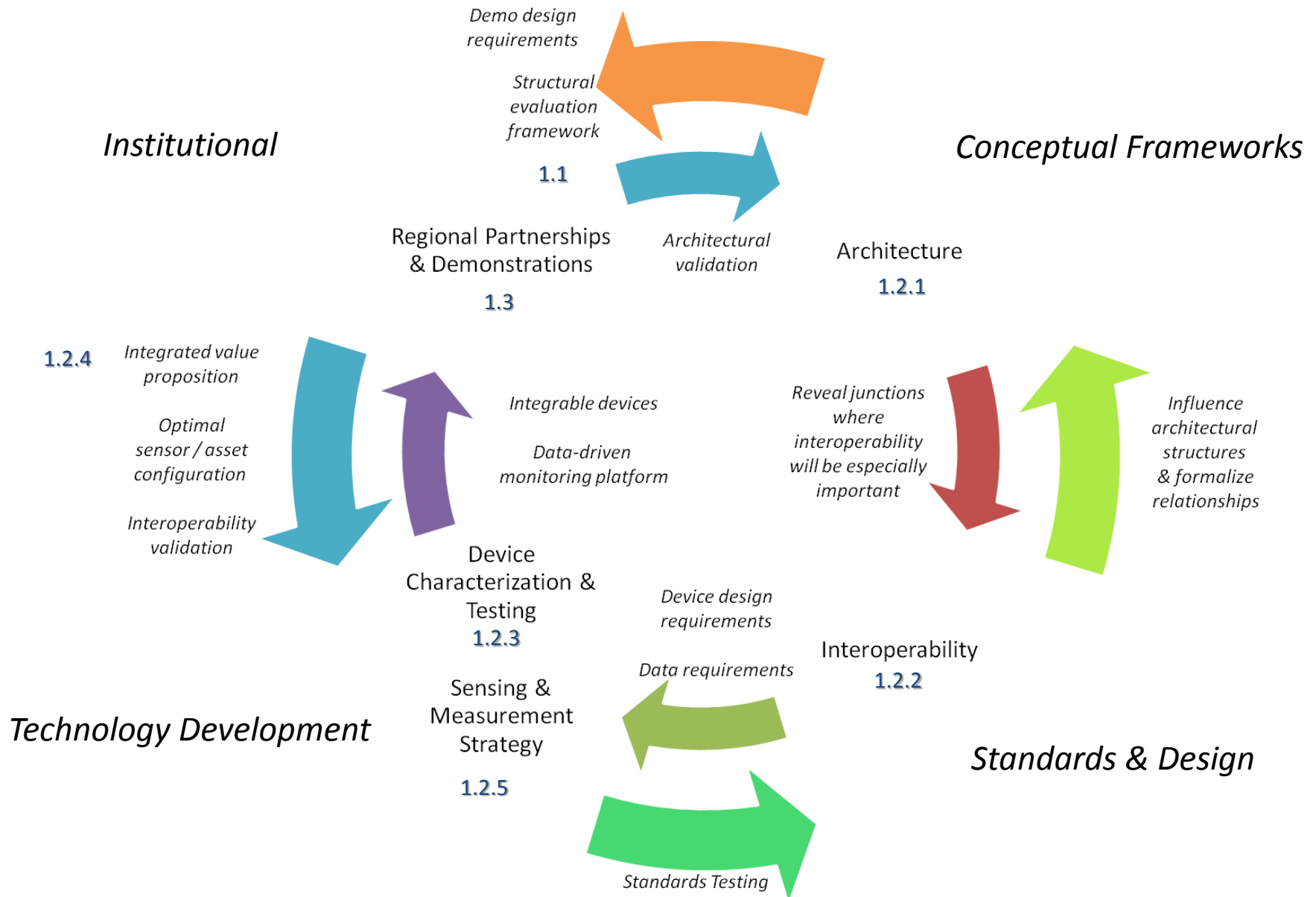
Core Activities

The Foundational Research projects provide the fundamental knowledge, metrics, and tools needed to support all the Cross-Cut R&D and regional partnerships. They provide the framework to enable an integrated DOE grid modernization strategy, including:

- **Metrics and Baseline**: fundamental metrics to guide and evaluate national progress in grid modernization;
- **Grid Architecture**: future grid and industry design elements to guide consideration of new industry paradigms;
- **Interoperability**: standards and protocols for interoperability and testing of all grid devices from high voltage to customer premises;
- **Device Characterization**: an integrated testing network that spans the National Labs as well as industry and academia;
- **Valuation**: a consensus framework for valuing emergent grid technologies and services; and
- **Sensing Strategy**: a strategy for observing and monitoring the future grid system in a way that meets expectations for predictive control, real-time operations and security.



Foundational Strategy





State and Regional Engagement





Grid Frequency Support from Distributed Inverter-Based Resources in Hawaii

Drivers of change

★ Changing Electricity Supply Mix

Growing Threats to Resilience and Reliability

★ New Market Opportunities for Consumers

★ Information and Control Technologies

Aging Infrastructure

- **Challenge:**
- HPUC Docket 2014-0192 ("the Docket"), states that because the Oahu system is now less resilient to contingency events, "new measures may be needed to maintain system stability such as ... DER-based solutions to support system stability." These issues will only worsen as continued deployment of PV and wind further displaces the conventional generation whose rotational inertia and primary frequency response traditionally stabilize the grid in the critical first few seconds following a major loss of load or generation Hawaii Public Utilities Commission, "Staff Report and Proposal, Docket No. 2014-0192," March 31, 2015.
- **Solution from MYPP:**
Develop, simulate, validate, and deploy practical solutions in Hawaii that enable distributed energy resources (DERs) to help mitigate bulk system frequency contingency events on the fastest time scale (milliseconds to seconds). Validate the ability of real hardware inverters to support grid frequency in an environment that emulates the dynamics of a HECO power system.
- **Partners:**
Hawaiian Electric Companies, Enphase Energy, Fronius USA, Forum on Inverter Grid Integration Issues, Energy Excelerator

Primary Technical Area of MYPP

Devices and Integrated System Testing





Vermont Regional Partnership Enabling the Use of DER

Drivers of change

★ Changing Electricity Supply Mix

Growing Threats to Resilience and Reliability

★ New Market Opportunities for Consumers

★ Information and Control Technologies

Aging Infrastructure

- **Problem today:**

The *Vermont Comprehensive Energy Plan* (CEP) sets forth an ambitious and pioneering vision that calls for Vermont to obtain 90% of its energy from renewable sources by 2050, with a near-term goal for DG to reach 1% of electricity sales in 2017, rising to 10% in 2032

- **What MYPP will address:**

Assist Vermont utilities in meeting the state's ambitious goal of obtaining 90% of its energy from renewable sources by 2050 through (1) DER integration, (2) DER control, 3) validation of wind and solar forecasting, and (4) techno-economic analysis of energy storage.

- **Partners:**

Green Mountain Power, VT Electric Cooperative, VT Electric Company, Univ of VT

Primary Technical Areas for Demo

System Operations, Control and Power Flow





California Distributed Resource Planning

Drivers of change

★ Changing Electricity Supply Mix

Growing Threats to Resilience and Reliability

★ New Market Opportunities for Consumers

★ Information and Control Technologies

Aging Infrastructure

- **Challenge:**
AB 327 requires the electric utilities in California to file Distribution Resources Plans (DRPs) to identify optimal locations for the deployment of distributed resources
- **Solution from MYPP:**
Deliver an online open-access integrated distributed resource planning and optimization platform
- **Partners:**
CA Public Utility Commission
Pacific Gas & Electric
Southern California Edison
NYSERDA
Metropolitan Washington Council of Governments
- **Expected impact:**
Identify meaningful behind-the-meter DER adoption patterns, potential microgrid sites and demand-side resources, and evaluate the impacts of high renewable penetration feeders on the distribution and transmission grid

Primary Technical Area of MYPP

Design and Planning Tools





Grid Analysis and Design for Energy and Infrastructure Resiliency for New Orleans

Drivers of change

Changing
Electricity Supply
Mix

★ Growing Threats
to Resilience and
Reliability

New Market
Opportunities for
Consumers

★ Information and
Control
Technologies

★ Aging
Infrastructure

- **Challenge:**
- Coastal cities in the Southeastern United States face a range of severe weather threats, including hurricanes, floods, and tornadoes. These threats can cause significant damage and disruption to cities, including loss of life, business interruptions and economic losses, and failure of critical infrastructure services. Many of these impacts occur because of failures in the electrical power system, so maintaining effective operations of critical systems and services during a major extended power outage is a growing concern to these cities
- **Solution from MYPP:**
Conduct technical evaluations to assess energy and critical infrastructure vulnerabilities, and to identify cost effective options to improve the resiliency of both the electrical grid infrastructure and the community.
- **Partners:**
City of New Orleans, Rockefeller Institute, Entergy, US Army Corps of Engineers

Areas of MYPP

Security and
Resilience



Energy is the Engine of the Economy

Vast and complex
Touches Everything
Concurrent daunting challenges
in the Face of stunning global growth
A wide range of options exists for future progress

QTR – available at energy.gov/QTR